A Study on the Conception for the Future SITMS Traffic Information Center

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ABSTRACT

The current Traffic Information Center with its host-oriented system makes it difficult to provide instant information while managing various types of traffic data. It also fails to actively respond to incidents with the system's extension and troubleshooting. This paper suggests the adoption of an advanced technology, SITMS (SMART Information and Traffic Management System), which allows the Center to provide the constant and instant flow of information through a SMART terminal. For the future Traffic Information Center, we propose the idea of a human-centered and environment-friendly automatic center and identify four specific goals – a green center, a human center, an automatic center, and an open center. Furthermore, this paper explores differentiated strategies for the construction of DBMS, UI, digital architecture, multiple collection/distribution platform, and middleware in an effort to materialize the Center's future goals and provide ideas for its required functions.

1. Introduction

The domestic ITS (Intelligent Transportation System) has utilized its system to primarily assist monitors' activities of collecting and managing data since it was adopted in 1996. Moreover, the Traffic Information Center with its host-oriented system cannot adequately respond to its system's extension, the improvement of an application system, and troubleshooting while managing various types of data. As a result, the Center requires extensive human resources and time in the processes of constructing and managing its system. The SMART highway is a significantly improved traffic system that is more punctual, safe, convenient, and environment-friendly compared to the current road conditions and traffic system. As a highly functional and intelligent traffic system that can satisfy future generation's needs, the SMART highway system requires an alternative concept and approach in order to help overcome the problems with the current traffic system such as incessant traffic jams and accidents. Its primary function is to promptly provide information and services for traffic system administrators and drivers through the constant and instant flow of information using a SMART terminal. This paper aims to introduce the main elements of the SITMS for an integrated management of

its services, create a systematic structure of the new Center by analyzing the mechanisms of the SITMS services, and finally propose major functions of the future Center that is based on the advanced SITMS technology.

This paper consists of four parts. The following chapter describes the current states of the highway traffic information center at home and abroad respectively. Chapter 3 explores the future Traffic Information Center's goals and functions in order for the construction of an optimum information system and its efficient management. Chapter 4 provides a detailed analysis of the major concepts in the SITMS Traffic Information Center's integrated platform as well as the systematic structure of the Center for the application of the SITMS services. Finally, chapter 5 functions as a conclusion of this study, in which we point out where further study is needed.

2. The Analysis of Highway Traffic Information Center's Current Conditions

2.1. Domestic Conditions

The Korea Highway Corporation began to utilize a Freeway Traffic Management Systems (FTMS) in 1993 and manages a total of 25 highways which are 3,132 kilometers in length presently in 2008. The Corporation strives to optimize current highways and create a safe driving environment by way of the control and decentralization of traffic flows and the efficient use of highway infrastructures. The Corporation also utilizes an optical communication network based on a high-speed transmit system with 2.5 Gbps, which functions as a core infrastructure for the intelligent traffic system including FIMS, ETCS, computer network, and emergency phones. This optical communication network will play an important part in connecting serve systems for a high-tech traffic system in the future. The Korea Highway Corporation's FTMS system consists of three subsystems: information collection system, information processing system, and information distribution system.

- The information collection system gathers traffic information through loop-type, magnet-type, and image-type vehicle detection systems and CCTV, and delivers the information to the information processing system through the Corporation's communication network.

- The information processing system processes the gathered information to be used to monitor and report on-going traffic conditions.
- The information distribution system presents and distributes the processed information through VMS. The distribution takes place in the form of cell phone text messages, broadcasting through radio, television and the Internet, and ARS system.

The previous projects relying on the notion of integrated management center mainly comprise urban integration management centers such as “u-City construction projects” in Dong-tan (Hwa-sung city), Heung-duk (Yong-in city), Un-jung (Pa-ju city), Pan-kyo (Sung-nam city), and Kwang-kyo (Su-won city). However, such projects as urban integration management centers remain in its early stages and thus present a gap between theory and practice due to the lack of completed projects. Specifically, further research is needed in regards to the distribution of integrated services through an integrated platform.

Developed countries are currently at work developing large-scale ITS projects, which enable wireless communications between the roadside and vehicles, in order to improve road safety and embody an ideal ITS service environment. The most representative cases are the US’ Vehicle Infrastructure Integration (VII), Japan’s Smartway, and Europe’s CO-Operative systEms for intelligent Road Safety (COOPERS).

2.2. Cases in Developed Countries

The VII project in the US provides much improved traffic information and services through GPS receivers and terminal equipments with 5.9GHz active DSRC installed in vehicles as well as GPS receivers, DSRC antennas, GPRS (General Packet Radio Switch) modems installed in the roadside.

Japan’s Smartway project utilizes a 5.8GHz active DSRC technology along with the existing services such as ETC and VICS in an effort to provide various types of services while using one integrated terminal equipment. Japan plans on expanding this project nationwide upon testing its technology.

Table 1. Integrated Management Center At Home and Abroad

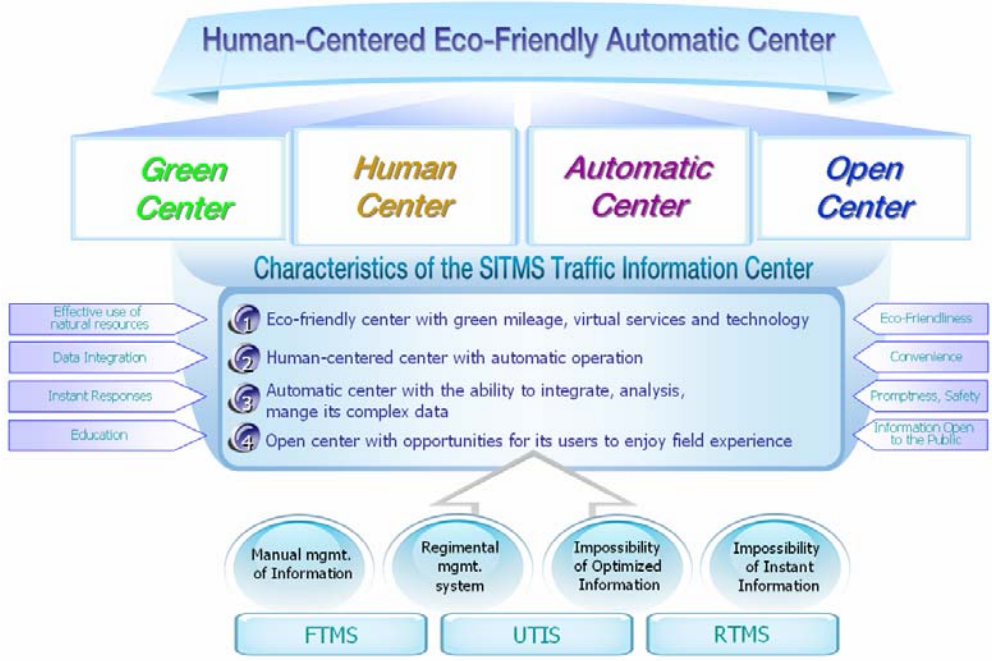
Services	Abroad			Korea					
	USA	Japan	Europe	Traffic Information Center			u-City		
	VII	Smartway	COOPERS	FTMS	exTMS	SITMS	Dong-tan, Hwa-sung	Un-jung, Pa-ju	Pan-kyo, Sung-nam
Safe Driving Guide Service	O	O	O		O	O			
Navigation Information Service	O	O	O		O	O			
Travelers' Convenience Service	O	O	O		O	O		O	O
Electronic Toll Payment Service	O	O	O	O	O	O			
Navigation Safety Service	O	O	O		O	O			
Self-Driving Support Service						O			
Transportation Management Service			O	O	O	O	O	O	O
Accident Management Service	O		O	O	O	O	O	O	O
Automatic Traffic Regulations Service				O	O	O	O	O	O
Traffic Information Management and Distribution Service	O	O	O	O	O	O	O	O	O
Traffic Facilities Management Service				O	O	O	O	O	O
Traffic Environment Management Service			O			O			
Commercial Vehicles Management Service			O			O			
International Information Exchange Service			O						
Public Parking Payment Service		O							
Public Parking Information Service							O		O

3. Planning the Future SITMS Traffic Information Center

The planning of the future SITMS Traffic Information Center focuses on the convenience and eco-friendliness of the Center's use and management, which is one of the primary objectives of this study, and relies on the use of an optimized and advanced technology. Figure 1 shows that the future Center functions as a green, human-centered, automatic, and open center. The following describes the Center's functional elements:

- Digital architecture that allows its space to organically communicate
- Eco-friendly center that effectively utilizes computing resources to reduce energy consumption and help the environment.
- Human-centered center to provide information optimized for its users
- Automatic center that integrates various and complex data with its automated operation
- Open center that is open to everybody and provides traffic information instantly to those who need.

Figure 1. The Future Traffic Information Center



3.1. Eco-friendly Center with Green Service

We propose that the Center should make an effort to reduce CO2 through an active control of vehicles, to reduce its energy consumption, and to utilize an effective energy management system. To do this, we propose strategies for the effective use of energy in IT infrastructures and in facilities infrastructures as well as strategies for eco-friendly services. In other words, the Center needs to construct effective IT infrastructures and improve its facilities management through centralization, virtualization, and application integration. The Center also needs to construct effective facilities infrastructures by utilizing an up-to-date energy management system, and provide eco-friendly services such as the green mileage service.

3.2. Human-centered Center with Automated & Customized Services

The Center currently functions as a secondary means to manual operations by humans. However, the future Center should be able to automatically respond to a variety of situations without any human interventions. Human-centered services refer to the optimization of its user's convenience by automating and customizing their operation. In short, the Center should be able to personalize their services to fit with a particular user's needs, and provide one-stop services in the event that additional services become available.

- User-friendly UI: for each user to customize the Center' services based on his/her personal needs
- Customized information: to provide customized information based on a particular user's circumstances
- Standardized automatic database: to construct a database system that is each to create and manage by standardizing the Center's system
- Distance management of the system: to maintain and manage every elements that involve in the Center's information services regardless of time and location.

3.3. Intelligent Center with Integrated Context Cognition System

"Context Cognition Computing" began with a study of the human-computer relationship and is currently at a developing stage along with a ubiquitous computing system. The definition of "context" in general means circumstances or a surrounding of a certain

situation. The “context” in “Context Cognition Computing” refers to the effects of the human relationships with its surroundings including a type of information that specifies an object, an application of information between users, objects, and surroundings. For instance, in the case with air-conditioning or heating devices, users can set a particular temperature using a programmable thermostat so that the air-conditioner or the heater would automatically turn on and off at the set temperature. The interior temperature, here, can be seen as a context to which such cognitive system as the operation of the air conditioner or heater in order to change the interior temperature.

The Integrated Context Cognition System on which the new Center will be based is expected to provide integrated and systematic information according to the set rules and thereby improving the credibility of data and minimizing the interference of human operators. This will make it easy to manage the Center’s information and services as well as to add new services in the future.

3.4. Open Center whose Facilities and Information are Open to the Public

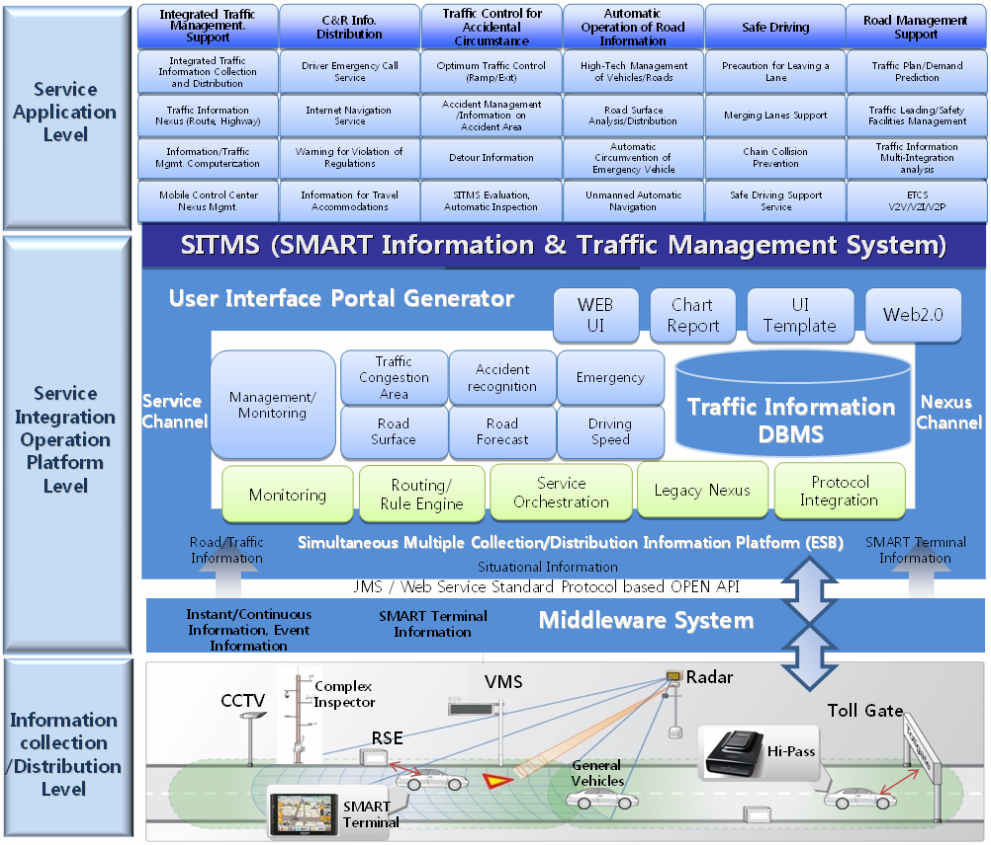
The current Center generally maintains a closed management style in terms of its system and services. By a closed system we mean the one-directional distribution of information and closed-door operations of the Center’s services. However, the most recent information services rely on an open system where its services can be customized to specific users. The Center should also serve educational purposes for the public as a place where users can build a hands-on experience since the roads and highways are public properties. For instance, it should provide educational services such as a virtual experience, safety instructions, exhibitions, and instructions for future traffic facilities professionals.

4. SITMS Traffic Information Center’s Integration Management Platform

The Integration Management Platform is central to the SMART highway system in terms of promptness, safety, convenience, and eco-friendliness because it enables a smooth operation of the various SITMS services by collecting, processing, and

distributing information more effectively. It integrates data, business process, services and UI, and then processes, controls, and distributes such integrated information. Therefore, it functions as a basis for SMART highway's efficient operation. As you can see in figure 2, the SITMS Traffic Information Center collects a variety of information from the traffic and communication networks within the SMART highway, and then distributes the gathered information along with the information derived from other application services via various platforms.

Figure 2. SITMS Traffic Information Center's Integration Management Platform



As a mechanism to provide core functions of the SITMS services, the Integration Management Platform serves as a standard for open-end services and the system's interconnection and extension. It also supports a systematic integration while avoiding a duplicate development. Table 2 summarizes the SITMS Traffic Information Center's

functions in terms of its collection, management, distribution, and integration of information.

The Integration Management Platform not only functions as a two-way intelligent middleware that instantly collects and distributes extensive amount of information but also manages the information platform for a multiple collection and distribution of such extensive amount of data through DBMS and UI (User Interface).

Table 2. Functions of SITMS Traffic Information Center

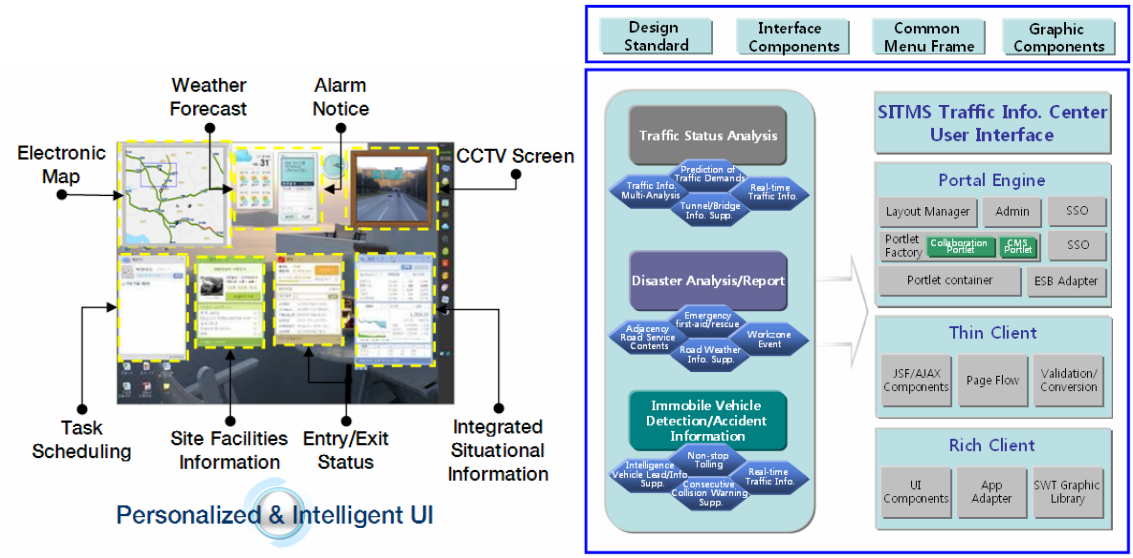
Data Collection	Data Management	Data Distribution	Data Integration and Interconnection
- existing system and related organizations - existing data collection devices - SITMS collection devices (information on the traffic, roads, & vehicles, and information from users) - SITMS service output data	- integrated inspection of collected information & instant analysis of its quality - active management of SITMS' infrastructures such as facilities and communication networks - management of the integrated control room & customer services	- distribution of information on existing organizations and related systems - distribution of information on the SITMS information distribution devices - distribution of rule-based information on SITMS services	- core shared functions for SITMS services - interconnection and extension of data based on open-end standards - seamless services between roads

4.1. Customized UI

The customized UI provides a variety of screen compositions for administrative officials, managers and users at the SITMS Traffic Information Center to promote visual communication of information while also maximizing the productivity of the Center's operation via uniformly designed screens that can be customized for the users. The purpose of the customized UI is to receive various requests from the users using a simple

web browser, and to provide a more complex yet efficient UI for the administrative officials and managers at the Center. The customized UI should utilize a user-friendly screen composition rather than a fixed UI-type in order to quickly respond to ever-changing customer requests, and the modification and addition of services. It also should define and provide standard designs and interface components for the construction of a consistent UI program in relation to the entire SITMS services, as illustrated in figure 3.

Figure 3. The Conception of User-friendly Customized UI



4.2. Information Platform for Simultaneous Multiple Collection/Distribution

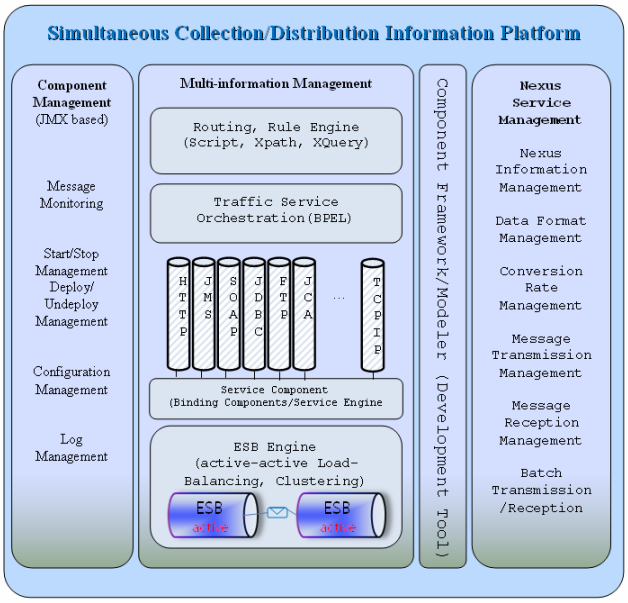
The Simultaneous Multiple Collection/Distribution Information Platform is central to the construction of the SITMS Traffic Information Center and it functions to synthesize, process, store, analyze, and distribute a variety of data. It also defines and manages various services at the Center, and provides interlocking services, routing, protocol integration, and monitoring. Furthermore, it designs and constructs the multiple collection/multiple distribution of data by identifying areas of data collection and distribution as well as areas of service management. This information platform, based on a SMART environment, describes calling-relations between services for the purpose of a particular operation, and facilitates the flow of interconnected activities between those who demand and provide services as well as interactions between service points. Such

platform should be formulated according to international standards in terms of end-point protocol and interlocking formula, message manipulation function, data type conversion function, protocol conversion and routing function, various adaptors, and instant interlocking formula through web services, as shown in table 3.

Table 3. Standards for Simultaneous Multiple Collection and Distribution Platform

Classification	Standard	Role
Content Based Routing	XML, XQuery	Standard for content based routing
Data Transformation	XSLT, XQuery	Rules for data transformation in messages
Asynchronous Messaging	JMS, WS-RM	ESB's asynchronous service request
Meta Data Management	XML Schema, DTD, XSLT, EDI	Meta data language
Transmission Security	JMS XA	Inter-service data transmission guarantee
Adaptor	JCA, JSM, JDBC, SOAP, File, FTP, Socket(TCP/IP), JSR181, XSLT/XQuery	Standard connection to interlock existing applications
Security	LDAP, SSL, WS-Security, X.509	Transport and message base security measures
Transmission Type	IIOP, TCP/IP, HTTP, FTP, X.25, SOAP, JMS, RMI, SMTP	Transmission protocols
Service Registry	UDDI	Service information storage
Integrated Framework	JBI	Standard based integration framework
Java Platform	J2EE, EJB	SUN Java Platform

Figure 4. The Structure of Simultaneous Collection/Distribution Information Platform



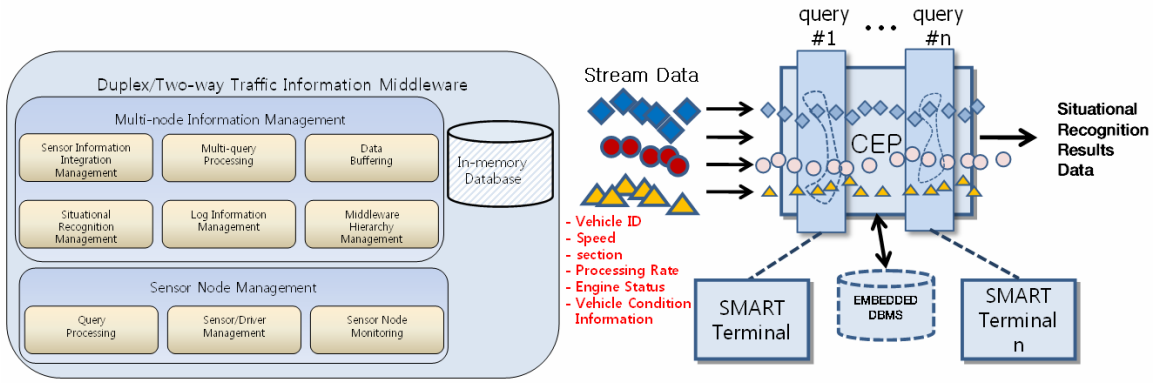
4.3. Two-way Traffic Information Middleware

The Two-way Traffic Information Middleware instantly processes extensive amount of data within the SMART highway context and provides a variety of interconnected channels in a standardized form. In the event of extensive amount of information with interconnected messages, the Middleware would store such information in a database, resolve a situation where it is impossible to continuously deliver information over 100,000-1,000,000 per second, and instead provide an EDA-type CEP (Complex Event Processor).

Unlike any previous processors, the EDA-type Complex Event Processor stores queries, allows data only for the stored queries, and receives and processes such data in its application services. Therefore, it effectively processes a complex event in terms of the following operations:

- extraction/selection of correlations between events
- selection function in response to the passing of time (maximum/minimum, total, mean, standard deviation)
- extraction of complex patterns and filtering functions
- efficient processing/analysis, pattern extraction of event via SQL-type EPL (Event Processing Language)

Figure 5. The Concept of Complex Event Processor



4.4. Extensive Amount of DBMS

The Center needs to establish a DB, tuning, and management policy in order to manage extensive amounts of original information as well as a variety of complex, processed information, which are produced from SITMS services and are provided through the Simultaneous Multiple Collection/Multiple Distribution Information Platform. DBMS functions like a hub of all data within the entire SITMS system and thus it is crucial to establish a DBMS of optimum performance. We propose the following tasks to be accomplished for the Center's DBMS:

- Analysis of information's input/output by the SITMS services
- Definition of SMART traffic information and DBMS index
- Establishment of data recovery and backup policies
- Definition of inquiry time resulting from a high-speed environment
- Traffic information DBMS inquiry tuning

In addition to these traditional DBMS operations, this paper proposes more unique and distictive strategies for the future Center's DBMS: (1) the creation of a more advanced virtual DBMS than the hybrid DBMS, which will organically utilize existing memories and disks; (2) the distribution of highly-reliable data by constructing extensive data as an ontological map of knowledge; (3) the adoption of an optimum archiving technology for extensive data.

4.5. The Future Center's Digital Architecture

The future Center aims to go beyond merely providing information to the administrators and users' PCs and it aims for the seamless transmission of information in an actual ubiquitous environment through mobile phones, media boards, and the Center's architecture itself.

Digital Architecture's Prospective Effects:

- Facilities with two-way media
- Creation of an Information community
- Visualization of a "ubiquitous environment"
- Enhanced visual presentation of the Center

Digital Architecture should be applied to both the interior and exterior of the Center through the visualization of various information media, so that all the information can freely and organically flow.

4.5. The Hierarchical Structure of the Traffic Information Center

The Korea Highway Corporation's current structure of the highway traffic information center consists of a central traffic information center, local traffic information centers, and satellite traffic information centers. The SITMS Traffic Information Center aims for an integrated information center in which the SITMS services can be promptly and smoothly provided on the very spot where an accident or incident happens.

All of the services at the SITMS Traffic Information Center are required to prove their efficiencies via a practice-based efficiency test. Furthermore, the new SITMS center at the local and satellite levels are expected to work collaboratively with the existing traffic information centers in order to create an environment for the effective execution of the efficiency test. Small-unit traffic information centers shall be established to provide their services in regards to urgent safety problems where immediate help is needed. The final structures and operations of the multilevel traffic information center require further analyses on the detailed requirements of each service at the Center.

5. Conclusion and Further Study

This study explores the concepts and functions of Simultaneous Multiple Collection/Distribution Information Platform, Middleware, DBMS and UI, which are central to the construction of the SITMS Traffic Information Center's Integration Management Platform. It also proposes the multilevel structure of the Center, which is currently at work corresponding to each service's requirements, and major functions of the future SITMS Traffic Information Center characterized by its services' convenience and eco-friendliness.

For further research, this study suggests (1) a more detailed analysis of requirements of various SITMS services to set a standard for the interconnected information center; (2) a detailed examination of technology that consists of the Integration Platform in relation to the SITMS environment; (3) the conception of various operations in relation to automated management and their efficiency test; (4) more research on each subsystem's roles within the entire SITMS system in collaboration with other research organizations. In regards to the future of the SITMS Traffic Information Center, we assume that the Center will serve as the integral control center for the entire highway system and expect that the Center shall develop into a part of the national "green energy" project that involves diverse advanced technologies.

Acknowledgement

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